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Provenance Studies on Tambo River Bedload Deposits, Eastern Victoria

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ABSTRACT: The geological nature of the Tambo River drainage basin is summarized and a lithological map presented. At nine sample points along the course of the river the lithological composition of the gravel load in the long axis size range of 32-64 mm was determined. Its relationships with the outcrop pattern were investigated using the techniques of Tricart (1959).

For a number of rock types the ratio between the percentage area of outcrop (Q_o) and the percentage content in the bedload of the stream (Q_t) was investigated and this ratio (Q) was found to be characteristic for each lithology.

Application of the technique to a number of basins may aid understanding of the inter-relationships between the nature of fossil alluvial deposits and the lithological composition of the basins from which they were derived.

INTRODUCTION

Where it emerges from the highlands at Bruthen, the Tambo River in East Gippsland, Victoria, has a catchment of approximately 1700 km^2. Steep slopes and a local relief of up to 600 m characterize the basin, with the highest peaks in the northern part reaching heights of more than 1500 m.

Much of the river channel is gorge-like, with short stretches of floodplain and river terraces restricted to small basins where the river passes through more erodible rocks. The stream carries a heavy bedload and the channel is wide and shallow with a tendency towards braiding where the presence of fossil alluvial and colluvial deposits allows rapid bank erosion.

The Tambo River was originally selected for this study because of its heavy bedload and because access is facilitated by the fact that it is paralleled for much of its course by the Omeo Highway.

Contour information is available for the whole of the catchment but the scale and quality of map cover varies. The methods used required the compilation of a lithological map of the basin. Unfortunately, geological mapping is of a variable standard and the limited information available on some parts of the basin restrict the usefulness of the techniques applied.

REGIONAL SETTING

Climate and Vegetation: Climate is extremely variable because large altitudinal range and extreme local relief cause marked variations depending on site and aspect. The only climatic stations within the basin are located in river basins and valleys at low elevations, and show marked rainshadow effects.

Examination of the records of higher altitude stations elsewhere in the Victorian Alps suggests for mean annual precipitation a range from 1750 mm in the highest parts of the basin down to 600 mm in sheltered valleys within 300 m of sea level. Mean annual temperature ranges from 5°C at the highest elevations to 14°C near sea level. Although snow is frequent in winter above 1000 m, there is no evidence of significant present day periglacial weathering and mass movement, but fossil periglacial landforms indicate much colder conditions in the past.

Most of the catchment remains under forest, with clearing restricted to small basins developed on more erodible rocks and to the floodplain and terraces of the Tambo River. Land clearing has locally caused severe accelerated erosion resulting in increased reworking of older alluvial and colluvial deposits. Vegetation ranges from dry open sclerophyll forest below 500 m to wet

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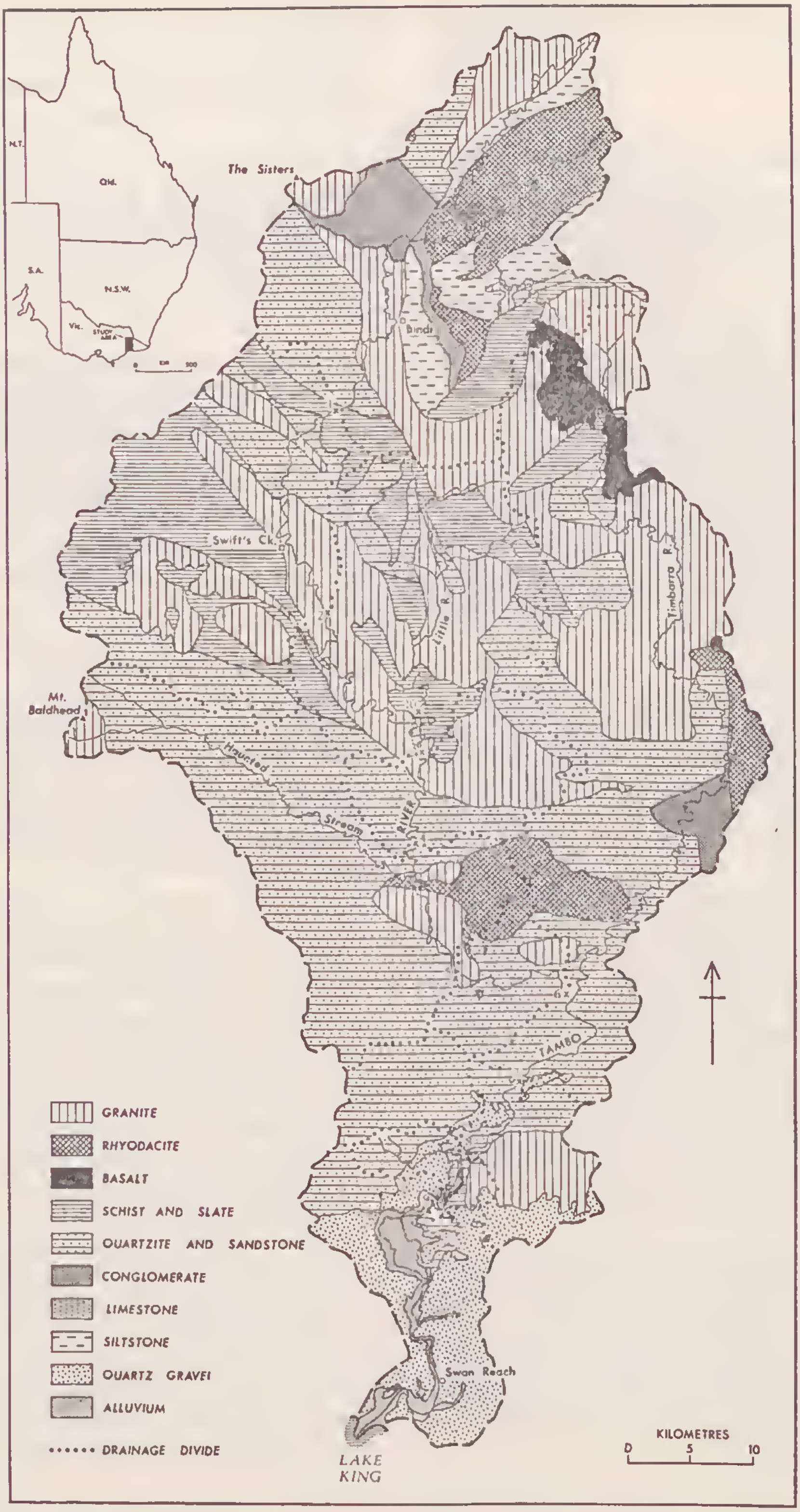

FIG. 1—Lithological map of Tambo River basin.

sclerophyll forest and some sub-alpine woodland at higher altitudes.

Geology and Geomorphology: The geology of the catchment area of the Tambo River has not been mapped systematically with the exception of a small area around the mouth of the Tambo which is included in the Bairnsdale geological sheet (1 : 63,360) published in 1960. To compile a lithological map of the area (Fig. 1) requires recourse to and reliance on published regional studies such as those by Gaskin (1943) of the Bindi area, Fletcher (1963) whose mapping included part of the Timbarra River catchment, and Tattam (1929) who studied the metamorphic belt extending into the Tambo catchment from Omeo to the south-east as far as Ensay. Other material is available in the form of published and unpublished reports and maps produced by the Geological Survey of Victoria including material prepared for inclusion in the Geological Map of Victoria (1 : 1,000,000) published 1963. Some information was also obtained from unpublished theses in the Geology Department of the University of Melbourne. The most important study was by W. Williams (unpublished) which included some detailed mapping of the granite complex in the Brookville-Swifts Creek-Ensay area.

An excellent summary of the geology of East Gippsland is given by Talent (1969). While dealing mainly with the stratigraphic sequence and geological history it also includes small sections on landforms and geological structure. A briefer account of the physiography, geology and mineral resources of the East Gippsland region is given by Thomas (1954), while some information on the geological structure of the area is found in Thomas (1958). Determination of potassium-argon ages of some of the East Gippsland granites by Evernden and Richards (1962) has helped to elucidate the geological history. A brief account of the geological nature of the area will be given (Fig. 1). Percentage area of outcrops refers to the area drained by the river at sample point 9, a short distance upstream from Bruthen.

Granitic rocks occupy nearly 30% of the drainage basin and range in age from Ordovician to Triassic. They vary from massive granites and granodiorites to gneissic granites and granite porphyries. As the present state of geological mapping does not allow the exact nature of each outcrop to be determined, they have been grouped together for the purpose of analysis.

The term rhyodacites is used to refer to outcrops of acid to intermediate volcanic rocks which are predominantly composed of rhyodacites and rhyolites but also include some ignimbrites and tuffs. These rocks are assigned to either the Silurian Mitta Mitta Volcanics or the Devonian Snowy River Volcanics and crop out over only 7·5% of the drainage basin. Nevertheless, they make an important contribution to the bedload.

Basalt outcrops in the drainage basin are confined to a belt 16 km long and up to 5 km wide underlying the Nunniong-Nunnett Plains and make up only 1·3% of the basin area. They are probably mid-Tertiary in age (Talent 1969, Beavis 1962).

Schists and slates are characteristic of the metamorphic belt associated with granitic intrusives and extend into the Tambo catchment from Omeo to the south-east as far as Ensay. They occupy just over 13% of the catchment area.

Outcrops of quartzite and sandstone are not readily distinguished at the present scale of geological mapping and have been grouped together. Most of the outcrops consist of great thicknesses of uniform, rhythmically bedded sandstones and quartzites of probable Ordovician age. These sediments represent a typical turbidite sequence characterized by graded beds, small scale cross bedding and flute casts. Sandstones are also present in the Wombat Creek Group of Silurian age and the Lower Devonian Timbarra Formation.

Plio-Pleistocene quartz gravels (Haunted Hills Gravels) make a significant contribution to the bedload of the Tambo River north-east of Bruthen and downstream from sample station 7. These gravels are clearly fluviatile in origin but are found 100 m and more above the present day river. Their distribution is shown separately in Fig. 1. Their contribution to the bedload of the Tambo cannot be separated from that made by quartzite and sandstone. The same applies to quartzitic material derived from conglomerates found in the Silurian Mount Waterton formation. Quartzites and sandstones together with quartz gravels and conglomerates make up nearly 45% of the drainage basin.

Limestone has a restricted distribution, cropping out near Bindi where it occupies only 0·41% of the catchment area. The limestone is correlated with the Buchan Caves Limestone of Devonian age (Gaskin 1943) and has an average dip of 30° to the WSW. with a prominent cuesta scarp marking the eastern boundary of the outcrop.

Siltstones are present in several geological horizons including the Silurian Wombat Creek Group as well as the Devonian Timbarra and

Taravale Formations. Together their outcrops account for only 3·9% of the drainage basin area.

In his description of the geology of East Gippsland, Talent (1969) gives a broad classification of five landform types of which three are represented in the area of study.

1. *Mountainous tracts* are defined as areas of strong relief with deeply incised valleys with accordant ridge tops common over distances of many miles. Occasional prominent mountain masses stand above these accordant summit levels as though representing residuals above a former widespread erosion surface.
2. *Tablelands* are undulating surfaces with broad valleys and low divides bevelling the high parts of the topography more or less regardless of rock type. Areas of Tertiary basalt (e.g. the Nunniong-Nunnett tablelands) are included in these.
3. *Intermontane basins* comprise small areas of low relief that are due to differential erosion of more easily eroded rocks. Examples from within the Tambo catchment given by Talent include the Bindi and Ensay-Swifts Creek areas.

A large proportion of the Tambo River catchment can properly be described as mountainous tract. As indicated in the introduction it is characterized by extreme local relief and very steep slopes.

Of considerable importance in relation to this study is the occurrence of periglacial and possibly glacial landforms and deposits in the Victorian Alps, since it must be considered highly likely that much of the gravel bedload of the present day Tambo River was made available by the prevalence of mechanical weathering by freeze and thaw, particularly at higher elevations during the cold stages of the Pleistocene.

Evidence for Pleistocene glaciation in the Victorian Alps has been brought forward by Carr and Costin (1955) who have claimed that the presence of ground moraine, asymmetrical hills, U-shaped valleys, truncated spurs and hanging tributary valleys is evidence of cirque and valley glaciation on the Bogong High Plains, Mount Bogong, Mount Hotham and Mount Feathertop. Beavis (1959) has since made a critical re-examination on the Bogong High Plains of the evidence presented by Carr and Costin and contends that their evidence is not substantiated by detailed field examination. He claims that '. . . it is possible to assert that no indisputable evidence of Pleistocene glaciation has been found on the Bogong High Plains'. More recently the evidence for glaciation of the Victorian Alps has been re-examined by Peterson (1969) in a number of areas and his findings are essentially in agreement with those of Beavis in that no unequivocal evidence of glaciation has been found. None of the localities where the presence of glacial features has been suggested falls within the area drained by the Tambo River and on present evidence glaciation cannot be considered as a process contributing to the gravel bedload of the river during glacial periods.

On the contrary, evidence of periglacial landforms appears to be widespread at higher elevations although little work has been done to assess their extent. Carr and Costin (1955) briefly mention the occurrence of boulder runs (?), stone polygons and stripes from several localities, particularly in association with basalt. The only detailed study of periglacial landforms is by Talent (1965) who has described blockstreams of rhyodacite boulders from Mt. Wombargo, Big Hill and the Cobberas extending down to altitudes of about 1200 m, and the occurrence of stone banked terraces composed of the same rock type. Evidence of the fossil nature of both landforms is presented. His observations indicate the susceptibility of the rhyodacites to frost weathering and this is of interest, because these rocks crop out extensively at higher elevations in the headwaters of the Tambo River and pebbles derived from them form a substantial proportion of the gravel load of the Tambo in the size range studied.

In the Victorian Alps little information is available on the lower limit to which periglacial processes were active but on the highlands of southern New South Wales this limit is thought to be at least 1000 m and possibly 700 m (Galloway 1965), while in Tasmania the limit was down to 300 m or even lower (Davies 1965, 1967). Using these figures as a guide, the general level of the lower limit of periglacial processes in the past must have lain somewhere between 500 and 1000 m. Davies (1969, pp. 12-13) has stressed, however, that this limit may vary depending on lithology and states that 'different rock types react differently to frost weathering and frost-induced mass movement—they vary in their readiness to be mobilized by frost. Because of this, periglacial conditions may appear to have extended nearer to sea level on some rock types than on others'. Much of the bedload transported by the Tambo River at present is probably derived by the reworking of colluvial aprons, fan deposits and older alluvial terraces built up under periglacial conditions. Remnants of massive gravel terraces and alluvial fans are particularly well preserved near Swifts Creek between Tongio and Doctors Flat.

Natural reworking of older gravels by the river has been accelerated by anthropogenic factors of which mining has been the most important. The late 19th century saw an upsurge of mining in the area, mainly of deposits of gold and cassiterite occurring in the form of alluvial deposits as well as some reefs and veins. The effect of mining operations has been to increase the amounts of older alluvial deposits being reworked by the stream as well as introducing 'foreign' material from hard rock mining operations: some of the vein quartz found in the gravel samples is probably derived from this source. The increase in load was undoubtedly further augmented by the resultant undercutting of alluvial banks adding still further to the supply of sand and gravel bedload of the stream.

SAMPLING

The method of sampling basically followed the pioneer study in this field by Tricart (1959) which, despite its original approach, seems to have made little if any impact in the English speaking world.

Sampling was restricted to a narrow size range (32-64 mm) as it has been shown (Tricart 1959) that lithological composition is strongly dependent on particle size and that, if the whole spectrum of particle size is examined, each rock type may be characterized by a narrow size range where its contribution to the sediment load is at a maximum. This modal value appears to depend on the physical and chemical properties of the rock and on the conditions of physical and chemical weathering which in turn are strongly influenced by climate.

The size range 32-64 mm was selected because particles in this range are sufficiently abundant to allow large samples to be collected, yet large enough to allow rapid visual determination of lithological type and accurate measurement of shape and roundness of quartzite and rhyodacite pebbles. The results of shape and roundness measurements are published elsewhere (Goede 1975).

Nine sample stations were established on gravel bars (either point or midstream bars) along the course of the river. The relatively small number of stations reflects the fact that the study reported here is part of a project involving the examination of sphericity and roundness of rhyodacite and quartzite pebbles. More or less equal spacing of stations was aimed for but actual sample localities frequently depended on accessibility

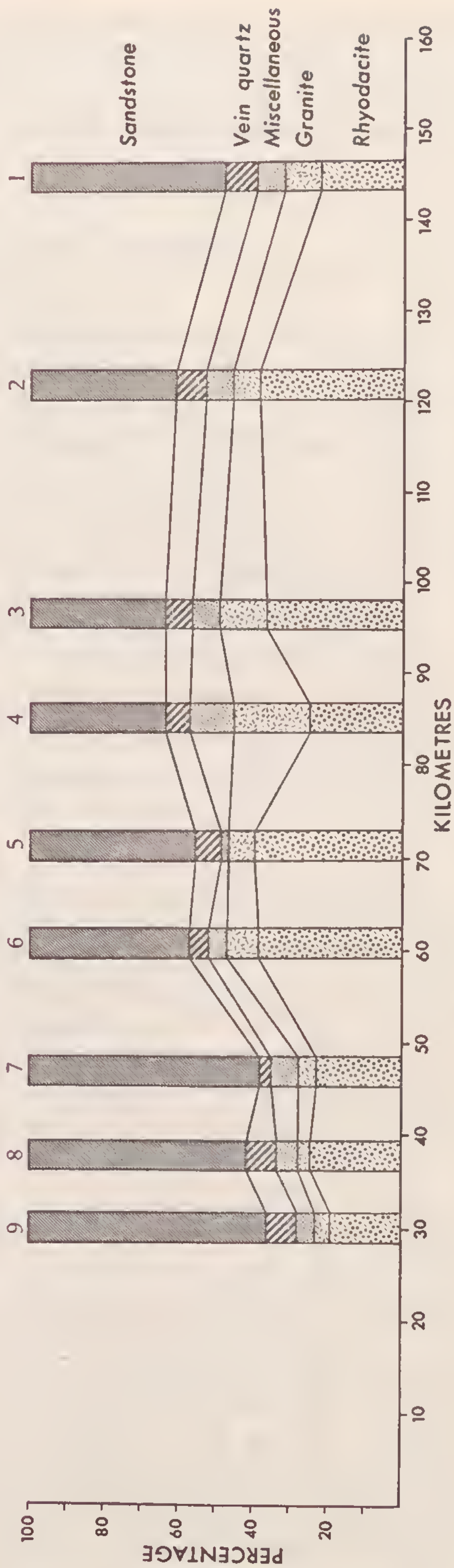

FIG. 2—Lithological composition of samples.

and the presence of abundant pebbles in the size class being sampled. At a selected point a peg was driven in and a circle one m in diameter set out. Working from the centre outwards two hundred pebbles within the long axis size limits of 32-64 mm were collected and identification of lithological content made on the spot.

Identification was made easier by the near absence of chemical weathering in most rock types. Pebbles were generally clean and fresh,

TABLE 1
Relationships between lithology of samples and outcrops.

Sample	Granites			Rhyodacites			Sandstones, quartzites			Limestones		
No.	Q_ℓ	Q_0	Q	Q_ℓ	Q_0	Q	Q_ℓ	Q_0	Q	Q_ℓ	Q_0	Q
1	9.5	25.75	0.37	22.5	20.56	1.10	52.5	27.02	1.94	-	2.05	-
2	7.0	27.32	0.25	38.5	11.63	3.31	40.0	27.19	1.47	-	1.15	-
3	12.5	32.28	0.39	38.0	8.72	4.36	36.0	25.76	1.40	-	0.87	-
4	20.0	33.29	0.61	30.0	7.55	3.97	36.5	28.39	1.29	-	0.78	-
5	7.0	28.02	0.25	39.5	8.07	4.90	44.5	40.00	1.11	-	0.62	-
6	8.5	27.45	0.31	38.5	8.14	4.74	46.5	41.40	1.12	-	0.59	-
7	4.5	29.95	0.15	23.0	8.07	2.86	62.5	41.75	1.50	-	0.44	-
8	3.0	29.20	0.13	24.5	7.87	3.11	60.0	43.30	1.39	-	0.43	-
9	4.0	29.34	0.14	20.5	7.49	2.74	64.0	44.40	1.44	-	0.41	-
$\bar{Q}$			0.29			3.45			1.41			

Sample	Basalts			Vein quartz			Schists, slates			Siltstones		
No.	Q_ℓ	Q_0	Q	Q_ℓ	Q_0	Q	Q_ℓ	Q_0	Q	Q_ℓ	Q_0	Q
1	-	0.80	-	8.5	?	-	7.0	8.61	0.81	-	15.21	-
2	1.0	0.45	2.22	8.0	?	-	5.5	23.66	0.23	-	8.60	-
3	1.0	0.34	2.94	7.5	?	-	5.0	25.58	0.20	-	6.45	-
4	-	0.31	-	6.5	?	-	7.0	23.75	0.29	-	5.93	-
5	-	0.24	-	7.0	?	-	2.0	18.46	0.11	-	4.58	-
6	-	0.23	-	5.0	?	-	1.5	17.74	0.08	-	4.40	-
7	3.5	1.49	2.35	3.0	?	-	3.5	14.13	0.25	-	4.21	-
8	2.5	1.45	1.72	7.0	?	-	3.0	13.80	0.22	-	4.10	-
9	-	1.38	-	8.0	?	-	3.5	13.12	0.27	-	3.90	-
$\bar{Q}$			2.31						0.26			

although granite particles frequently showed a pronounced tendency towards granular disintegration, and slight weathering out of quartz and feldspar phenocrysts was observed in some rhyodacite pebbles at stations 8 and 9 (Fig. 1).

ANALYSIS OF THE DATA

The lithological composition of each of the nine samples collected along the Tambo River is illustrated in Fig. 2. It can easily be seen that the composition of the bedload within the size range studied is dominated by two lithologies: rhyodacites and sandstones. Others, including granites which crop out over large areas, form only a minor component. The deficiency in granite content appears to be due to the observed rapid granular disintegration of granite pebbles present in the bed material. The percentage of rhyodacite pebbles decreases markedly downstream from the Timbarra River junction (between stations 6 and 7) and reflects the more limited extent of outcrops of this rock in the Timbarra catchment.

To relate the lithological composition of samples to outcrop patterns a lithological map of the whole of the Tambo catchment was compiled (Fig. 1) and all information available at that time included. Unfortunately, the patchy nature and variable quality of geological mapping in the area renders the investigation of relationships between areas of outcrop and gravel composition less rewarding than might otherwise have been the case.

The approach used is similar to that used by Tricart (1959) for a number of rivers in France. For each rock type within each sample, Q_l, the percentage content in a particular sample, has been calculated. Similarly, at each sample point and for each lithology, Q_0, the percentage area of the catchment over which a particular lithology crops out, was also computed. Q is the ratio Q_l/Q_0 and gives an indication of the yield of material from a particular lithology, within the size class examined, in relation to other rock types. A value greater than one indicates an above average yield, a value of less than one below average yield (Table 1). For each rock type the values of Q from the nine stations have been averaged to give $\overline{Q}$. Although there is a good deal of variation between samples, a particular value of $\overline{Q}$ was found to characterize each lithology.

Values of Q_l, and therefore Q, cannot be determined for limestones and siltstones due to their absence from all nine samples. For basalts, Q_l cannot be determined for five samples and the value of $\overline{Q}$ represents the mean of the values of Q of the four remaining samples. The absence of pebbles belonging to these rock types appears to be due to relatively small areas of outcrop within the basin, particularly of limestones and basalts, and also because pebbles of limestones and siltstones are rapidly removed during transport: the latter are prone to rapid disintegration and the former are attacked by solution processes and are also subject to rapid abrasion because of their low hardness.

In the case of vein quartz it is not practicable to determine areas of outcrop and this problem has been discussed at length by Tricart (1959). Vein quartz is probably most common in the granitic rocks but also occurs in other rock types. Even if areas of outcrop could be calculated the value of $\overline{Q}$ would be suspect as a true measure of relative yield of debris under natural conditions in the size class being considered. Mining operations may well have provided a significant source of vein quartz in the recent past.

For rhyodacites, sandstones and basalts the value of $\overline{Q}$ is above one, although figures for basalt must be treated with caution because of the small number of pebbles involved. In the size class examined rhyodacites yield more material per unit area of catchment than any other rock type. This may reflect their susceptibility to frost weathering during cold climatic conditions (Talent 1965). The common occurrence of outcrops at high elevations, together with the resistance of these rocks to abrasion, breakage and chemical weathering under the prevailing environmental conditions, are other factors that must be considered.

For schists, slates and granites the value of $\overline{Q}$ was less than one, reflecting the tendency for these rocks to yield fragments that are rapidly broken down into smaller detritus during transport.

It was decided to investigate for one well represented lithology, rhyodacite, the possible relationships of Q with mean distance from outcrop (Di_r) and mean altitude of outcrops (Al_r) for each station. Mean distance from outcrops indicates the mean distance of transport and should be directly related to the amount of abrasion and breakage suffered by a sample of rhyodacite pebbles. Mean altitude was investigated to test the possibility that rhyodacite pebbles were derived predominantly by periglacial processes during the Last Cold Period of the Pleistocene. If so, one would expect outcrops at high elevations, where climatic conditions were more severe,

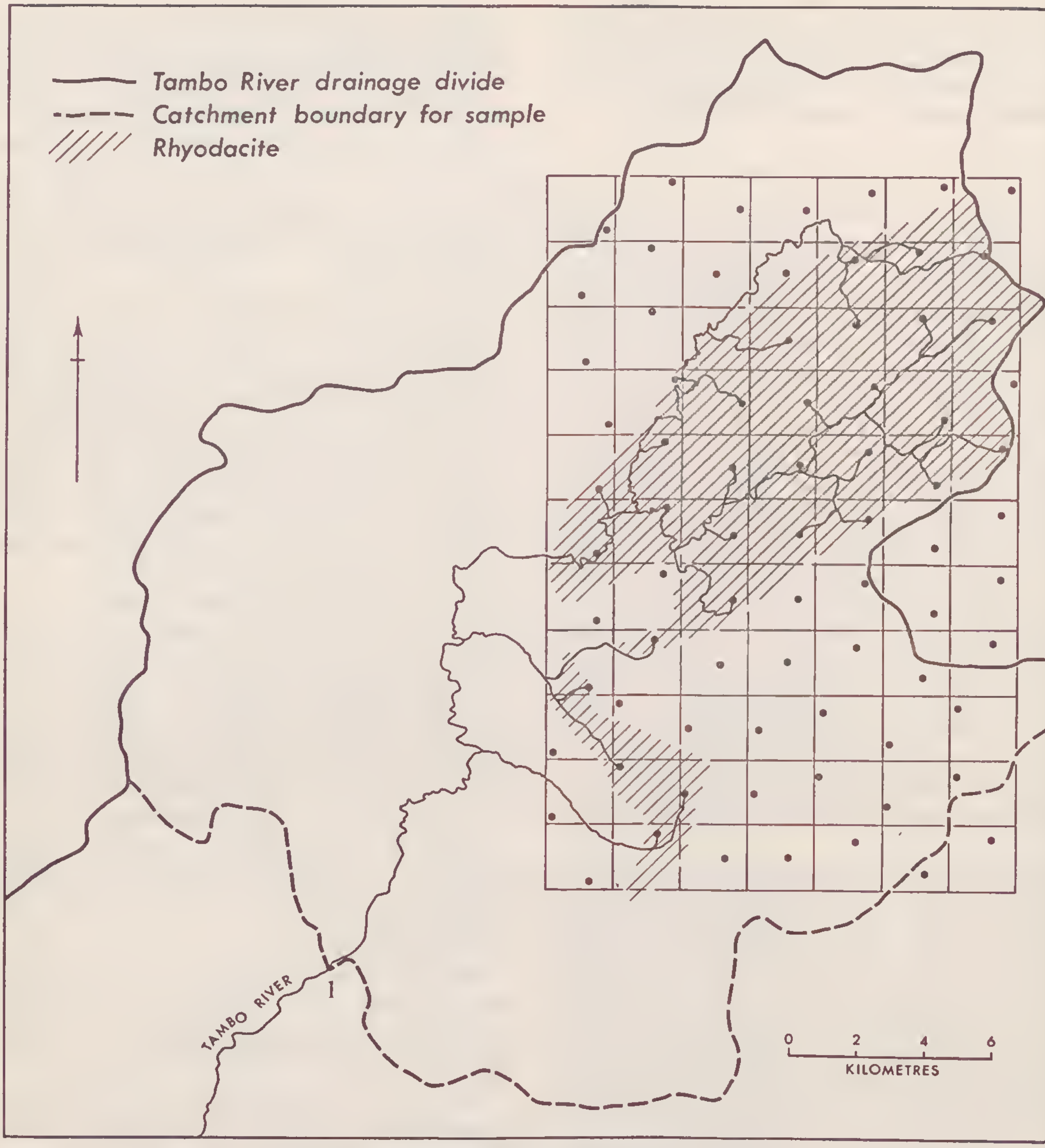

FIG. 3—Sampling grid for outcrops of rhyodacite.

to have contributed more material per unit area than those at lower elevations.

The first step was the superimposition of a 2000 m sampling grid over the catchment. Most of the area is covered by the 1 : 100,000 Omeo and Benambra topographic sheets with metric contours and grid, enabling the existing grid to be used for sampling. On non-metric maps covering the remainder of the area a metric sampling grid was superimposed. One sample point was selected within each grid square using the stratified systematic unaligned method of sampling in order to ensure an unbiassed estimate of mean altitude (Berry & Baker 1968). For each sampling point mean altitude of the outcrops (Al_r) was determined as follows. If a point fell on a contour its height was considered to be that of the contour while if it fell between two contours its height was taken as being half-way between the two. Where contour information was in feet the same procedure was followed but in conversion to metric units each value was rounded off to the nearest multiple of 20 m. From each point the distance to the location of the nearest gravel sample station was measured by the horizontal distance down the slope to the nearest stream and from there downstream along the channel. The horizontal distance rather than the slope distance was used because it is more easily measured. With the values involved in this study horizontal distances are very large compared with vertical distances. Changes in values obtained by substituting slope distance for horizontal distance would be very small and well within the margins of error for measurement of horizontal distance from topographic maps. Fig. 3 illustrates the sampling procedure in the area upstream from sample station 1. From this information the mean distance (Di_r) from rhyodacite outcrops to the sample location was calculated for each station. Correction factors were applied where distances were measured on maps of different scales. The measurements are shown in Table 2.

The next step was the correlation of Q with Al_r and Di_r. The correlation coefficient between Q and Al_r was ·036 indicating virtually no relationship between Q and mean altitude of outcrops. Correlation between Q and Di_r yields a coefficient of ·480 (Student's $t = 1·155$) and while this is not significant this may well be due to the small number of samples involved ($n = 9$). It indicates that 23% of the variation in Q can be explained in terms of variations in distance from outcrops.

Some of the variation in Q undoubtedly reflects error variance since the value of Q is subject to errors in geological mapping, sampling and field identification of rhyodacite. Since Q is related to Q_t, variations in Q are also induced by the varying abundance of other rock types.

Another related aspect of the lithological com-

TABLE 2
Values of Al_r and Di_r for samples of rhyodacite.

Sample No.	No. of points	Q	Al_r (m) (mean altitude of rhyodacite outcrops)	Di_r (km) (mean distance from rhyodacite outcrops)
1	31	1.10	1040.00	35.20
2	31	3.31	1040.00	57.91
3	31	4.36	1040.00	82.81
4	32	3.97	1040.38	92.03
5	40	4.90	928.00	87.54
6	41	4.74	921.95	97.59
7	54	2.86	830.37	95.23
8	54	3.11	830.37	104.50
9	54	2.74	830.37	112.16

position of the gravels investigated by Tricart (1959) was the relationship between changes in Q_l ($\triangle Q_l$) and changes in Q_0 ($\triangle Q_0$) between stations. He considered the significance of three possibilities.
Case 1—$\triangle Q_l > \triangle Q_0 > 0$
Case 2—$\triangle Q_l > 0 > \triangle Q_0$
Case 3—$\triangle Q_l < \triangle Q_0$
He further claimed that the three cases just stated gave information relating to the physical behaviour and degree of reworking of particular rock types between two stations. Before considering this it must be pointed out that Tricart's three cases are not exhaustive—other relationships may occur. To cover all possible relationships the following cases must be considered.

Case 1—$\triangle Q_l > \triangle Q_0$ (a) both positive
(b) $\triangle Q_l$ positive, $\triangle Q_0$ negative
(c) both negative

Case 2—$\triangle Q_l < \triangle Q_0$ (a) both positive
(b) $\triangle Q_l$ negative, $\triangle Q_0$ positive
(c) both negative

Case 3—$\triangle Q_l = \triangle Q_0$ rare occurrence

Values of $\triangle Q_l$ and $\triangle Q_0$ are set out in Table 3 for three lithologies: rhyodacite, sandstone and granite. Behind each pair of values the case which applied to the relationship between them is indicated. It can be seen that the relationship appears to vary in a completely random manner both within and between lithologies, and does not therefore support Tricart's contention. The influences of lithological constituents other than the one being considered probably affect the values of both $\triangle Q_l$ and $\triangle Q_0$ to such an extent that the relationship between them has little if any meaning.

TABLE 3
Values of $\triangle Q_l$ and $\triangle Q_0$ for Rhyodacite, Sandstone and Granite.

	Rhyodacite			Sandstone			Granite		
Sample No.	ΔQ_ℓ	ΔQ_0	Case	ΔQ_ℓ	ΔQ_0	Case	ΔQ_ℓ	ΔQ_0	Case
1									
	+16	-8.93	1(b)	-12.5	+0.17	2(b)	-2.5	+1.57	2(b)
2									
	-0.5	-2.91	1(c)	-4.0	-1.43	2(c)	+5.5	+4.96	1(a)
3									
	-8.0	-1.17	2(c)	+0.5	+2.63	2(a)	+7.5	+1.01	1(a)
4									
	+9.5	+0.52	1(a)	+8.0	+11.61	2(a)	-13.0	-5.27	2(c)
5									
	-1.0	+0.07	2(b)	+2.0	+1.40	1(a)	+1.5	-0.57	1(b)
6									
	-15.5	-0.07	2(c)	+16.0	+0.35	1(a)	-4.0	+2.50	2(b)
7									
	+1.5	-0.20	1(b)	-2.5	+1.55	2(b)	-1.5	-0.75	2(c)
8									
	-4	-0.38	2(c)	+4.0	+1.10	1(a)	+1.0	+0.14	2(a)
9									

CONCLUSION

Investigation of the relationships between the lithology of the Tambo River drainage basin and the lithological composition of gravel samples after the manner of Tricart (1959) has confirmed the Q ratio as a useful indicator of the relative contributions made to the bedload by different rock types in the size class studied. The accuracy of the Q ratio values can probably be improved substantially when accurate geological maps are available for the whole of the basin.

However, the relationship between ΔQ_l and ΔQ_0, which was considered by Tricart to give significant information on the physical behaviour of different rock types, appears to have no real meaning in the example studied and illustrates the problems involved in dealing with variables based on percentage values.

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